BARBER COLMAN

INSTRUCTION MANUAL

MP MASTER
MA32115

BARBER-COLMAN COMPANY
Industrial Instruments Div. • Rockford, Ill., U.S.A.

1211.6
IN 6

MODEL 481L - MODEL 481H

LIMITROLS

INTRODUCTION

This instruction manual is designed to help you secure maximum benefits from your new Series 481 Limitrols. It should be given to persons responsible for the installation, operation and maintenance of this instrument.

All information contained in this manual applies to both the Model 481L and the Model 481H unless otherwise noted. Elsewhere, reference is made to "Series 481", meaning either or both models.

Your Barber-Colman factory trained field engineer is always available for further help in the solution of your control problems. Offices are located in all principal cities.

BARBER-COLMAN COMPANY
Industrial Instruments Division

Litho in U.S.A.

F-12958 - July 1965

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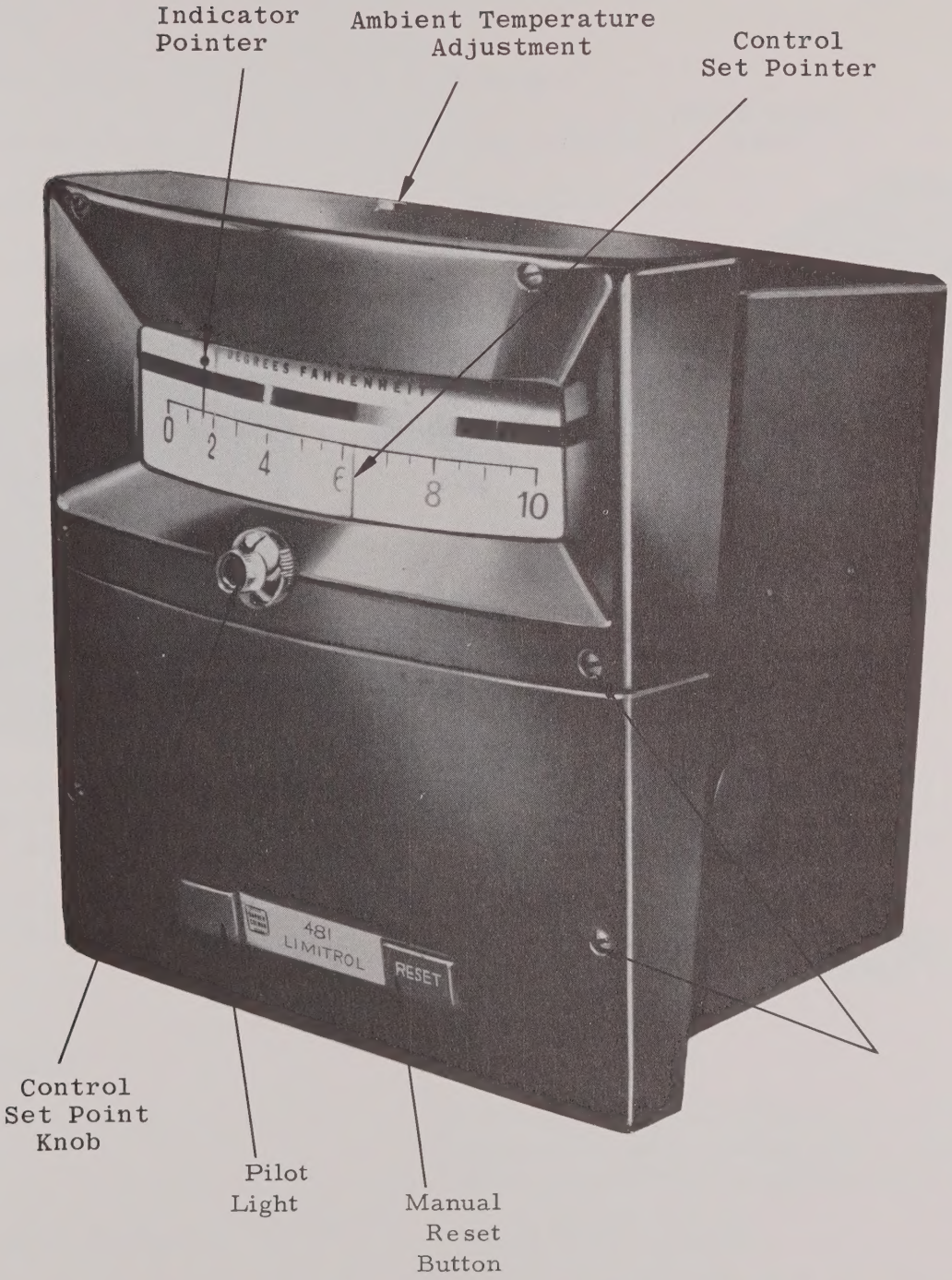
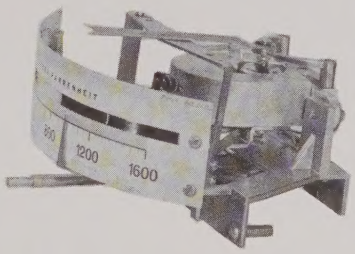


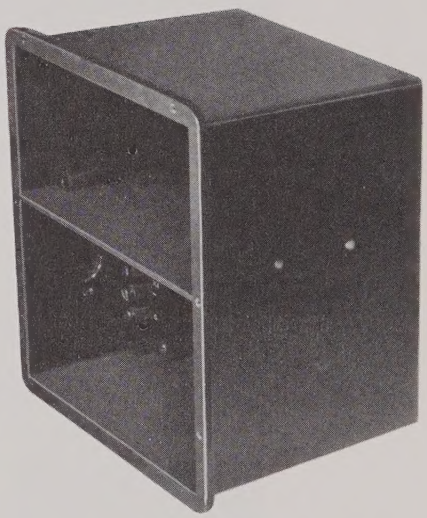
Series 481 Limitrol

F-12958

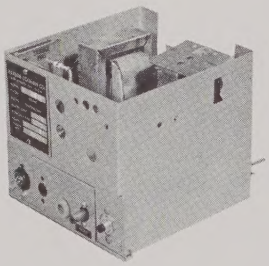
Upper Front Cover

Indicating Meter

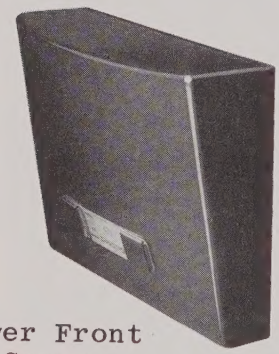




Compartmented Housing



Control Chassis
(Model 481L shown)



Lower Front Cover

SPECIFICATIONS

Meter

Scale Length	6 inches
Minimum Span	9 mv or 0-300°F - Type J
Calibrated Accuracy	1/2% of full scale
Sensitivity	50 microamps for full scale deflection (nominal)
Internal Resistance	20 ohms per millivolt (nominal)
External Resistance	a) As standard, calibrated for 15 ohms and supplied with replaceable compensator to make up difference between calibrated resistance and actual value of external resistance. May be calibrated for other values of external resistance if required. b) Units with bridge type TCB are adjustable for external resistances up to 20 ohms
Compensation	a) Automatic cold junction temperature compensation -- mechanical standard; electrical optional. Range 40 to 130°F
Thermocouple Break Protection	Standard type TCB furnished unless otherwise specified. Bridge type TCB available.

Chassis

Control Action	Automatic shut-off action on excess temperature requires manual push button resetting before power can be restored
Control Sensitivity	0.1 to 1% of full scale
Control Contacts	One set of SPDT contacts

Chassis (continued)

		120 v	240 v
Contact Ratings (Resistance Loads)	Model 481L	10 amps	5 amps
	Model 481H	30 amps	20 amps

Control Adjustment: External control set point knob adjustable over 100% of scale. Reset control internally adjustable

Power Requirements: 9 volt amperes

Power supply: Interchangeable: 120, 208, 240 volts a-c, 50/60 cycle

Dimensions and Weights

Overall Dimensions: 9 15/16" high x 9 5/8" deep x 9" wide

Cutout for Flush Mounting: 8 3/16" wide x 9 3/16" high

Note: Meter housing will extend approximately 6" into panel when flush mounted

Net Weight: Approximately 16 pounds

Shipping Weight: Approximately 23 pounds

DESCRIPTION

General Description and Application

The Models 481L and 481H Limitrols (designated henceforth as Series 481) are millivoltmeter-type temperature indicating and limiting instruments using solid state trigger-type circuitry to operate a relay for "on-off" type of control action. These instruments are usually used in conjunction with controlling instruments to provide insurance against human or instrument failures so that predetermined critical temperatures are not exceeded. Their use as indicating and limiting safety devices prevent temperatures from rising above the danger point of the equipment or process material by de-activating a controller or the power applied to a process. Fuel supply will automatically shut off at any specified temperature manually set on the indicating scale. If desired, the Model 481L may also be wired to sound an alarm. When used in combination with controllers and recorders, these instruments provide added protection to the entire control system.

Whenever the temperature limit is exceeded, as determined by the control point setting, the instrument goes to the "off" position and the red signal lamp will light. In the case of the Model 481L, the "off" portion of the control circuit will also actuate alarm apparatus if connected. The Limitrol will stay in this "off" condition until the meter indicator moves downscale from the control set pointer and the manual reset push button is depressed to actuate the instrument relay. Only then will power again be applied to the process.

The Models 481L and 481H are identical except the 481H employs a heavy duty relay for higher ampere contact rating (see specifications), and does not provide contacts for auxiliary alarm apparatus. Each instrument is suitable for applications compatible with its relay action including external relays, contactors, solenoid valves, valve control motors or any electrical loads which do not exceed the instrument relay ratings.

Description of Electronic Circuit

The Series 481 uses a transistorized oscillator and a silicon controlled rectifier (SCR) for limiting of the load temperature. At a position on the scale below the set point, the transistor collector current is great enough to trigger the silicon controlled rectifier, energizing a relay

(if push button has been depressed) so that power is applied to the load or process. As the indicator approaches the set point a small vane or flag, suspended from the indicating pointer, passes between two flat coils mounted on the set point arm. The presence of the flag between the coils changes the tuning of the oscillator circuit.

With the flag between the coils, the collector current decreases to a point where the SCR ceases to conduct, de-energizing the relay and shutting off power to the load. Conversely, when the flag begins to leave the coils, the collector current increases. With the push button depressed, the SCR is then triggered, energizing the relay and again applying power to the load.

The contact circuitry in the Model 481L consists of a SPDT relay action connected to terminals marked 1-2-3 which indicate high, common and low. Normally open contacts 2 to 3 are made when the temperature is below set point, and normally closed contacts 2 to 1 are made when the temperature is above set point. In the Model 481H, the SPDT relay action is used to energize the coil of a high capacity mercury relay, with load terminals provided near the front center of the electronic control chassis. Contact ratings for both models are as shown on the specification sheet.

INSTALLATION

Unpacking the Instrument

This precision instrument and its associated equipment have been carefully manufactured and packed at the factory. Remove the instrument and accessories from the packing box and check items against the packing slip. If the equipment is found to be damaged in transit, report damages to the carrier immediately. Repack in original packing box until ready for installation.

CAUTION:

Handle with care.
Safeguard instrument from shock before and after installation.
Avoid oil accumulation and exposure to moisture.
Keep instrument temperature under 130°F and over 40°F.

Mounting Instructions

Locate instrument to avoid excessive vibration, shock and temperatures outside the range of 40°F to 130°F. Avoid furnace walls, radiation of heat, machine frames and outside walls. Provide suitable shelter against moisture and temperature extremes if installed outdoors. Refer to appropriate drawing for mounting details (Figures 1 and 2).

Power Wiring

The instrument is wired for 120 volts a-c. If available power supply is other than this, the proper voltage can be selected as follows:

The lower front cover should be removed by loosening the two screws. The chassis assembly can then be removed by firmly pulling forward. A voltage selection board is located on the top left side of the chassis. The voltage can easily be changed by plugging the wires onto the proper pins as illustrated on the right side of the chassis enclosure.

The two marked pins #1 and #2 are used for the voltage range desired while the other pins are used for storing the unused wires. The wires are marked A, B and C. The connections are as shown below:

VOLTAGE SELECTION

Voltage	Lead "A"	Lead "B"	Lead "C"
120 v	Pin #1	Storage	Pin #2
208 v	Storage	Pin #2	Storage
240 v	Pin #2	Storage	Storage

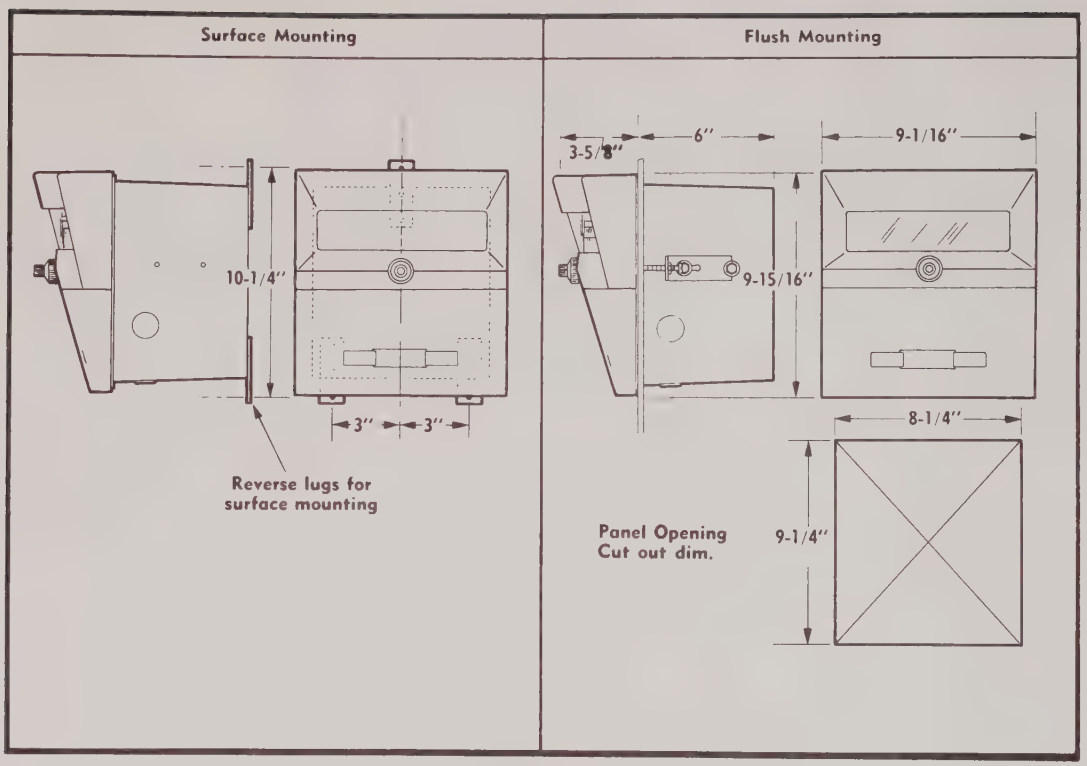


FIGURE 1
Mounting Dimensions
(Rigid Mounting)

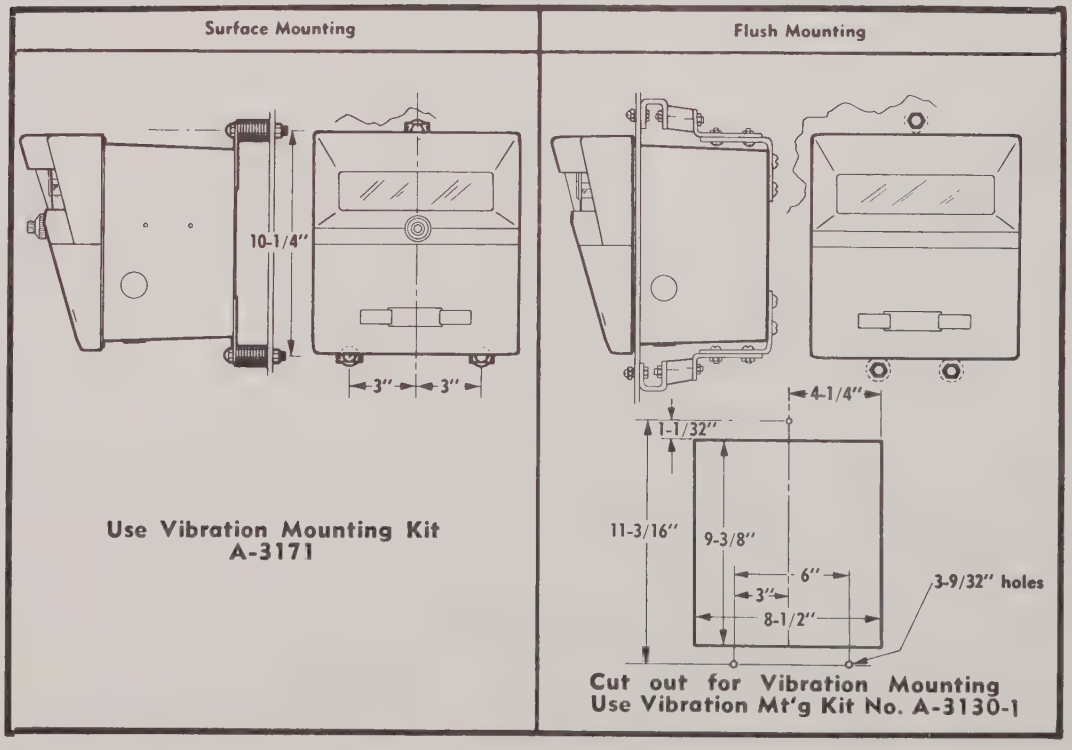


FIGURE 2
Mounting Dimensions
(Vibration Mounting)

After the proper voltage has been selected and the chassis replaced the instrument is then ready for wiring. The Series 481 will operate on both 50 and 60 cycle a-c systems. The desired a-c supply voltage is connected to terminals L1 and L2 inside the lower compartment. If the instrument is equipped for back wiring, remove the back panel to expose the terminal strips. All wiring should be in accordance with the applicable electrical codes. It is recommended that a fused switch be inserted in the power line to the load. The fuse size should never exceed the contact rating of the instrument. If load requirements are less than these amounts the ampere rating of the fuse can be less. Where maximum protection of the instrument is desired a 1/8 ampere fuse may also be added in the power line to the instrument.

Solid wire is recommended for instrument wiring. If stranded wire is used, tin the ends to provide secure connections. The Series 481 should be grounded. This is accomplished by attaching the ground terminal (G) directly to a good ground, such as a cold water pipe.

CAUTION: Do not connect the ground terminal to the neutral a-c line.

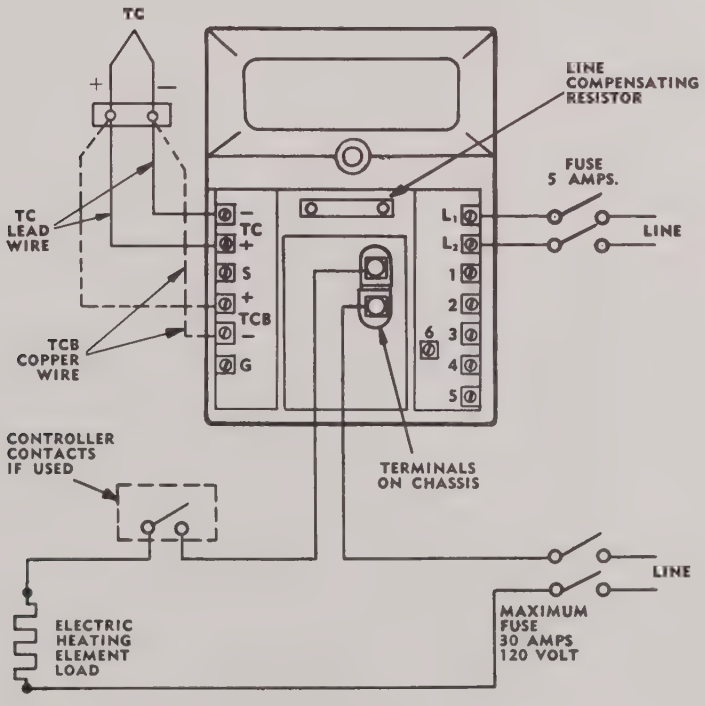


FIGURE 3

External Wiring Diagram of Model 481H
with Electric Heating Load

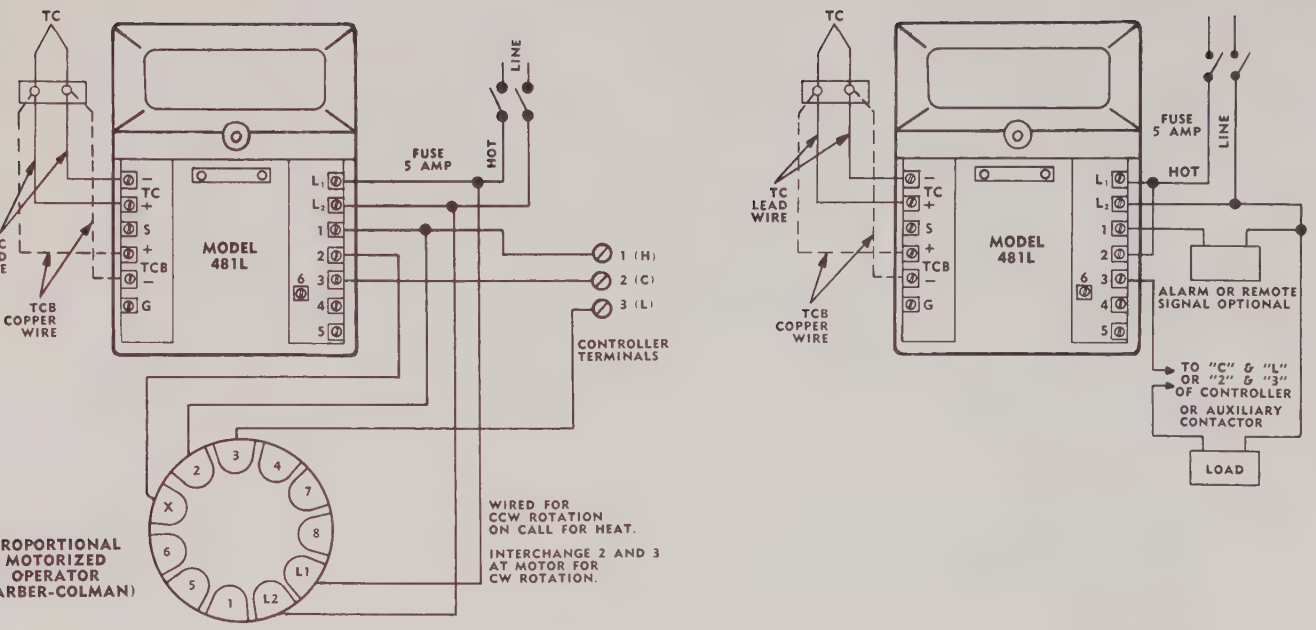


FIGURE 4

Model 481L and Controller with Motor Operator (left)
and with Solenoid Coil, Contactor or other Load under 5 amps (right)

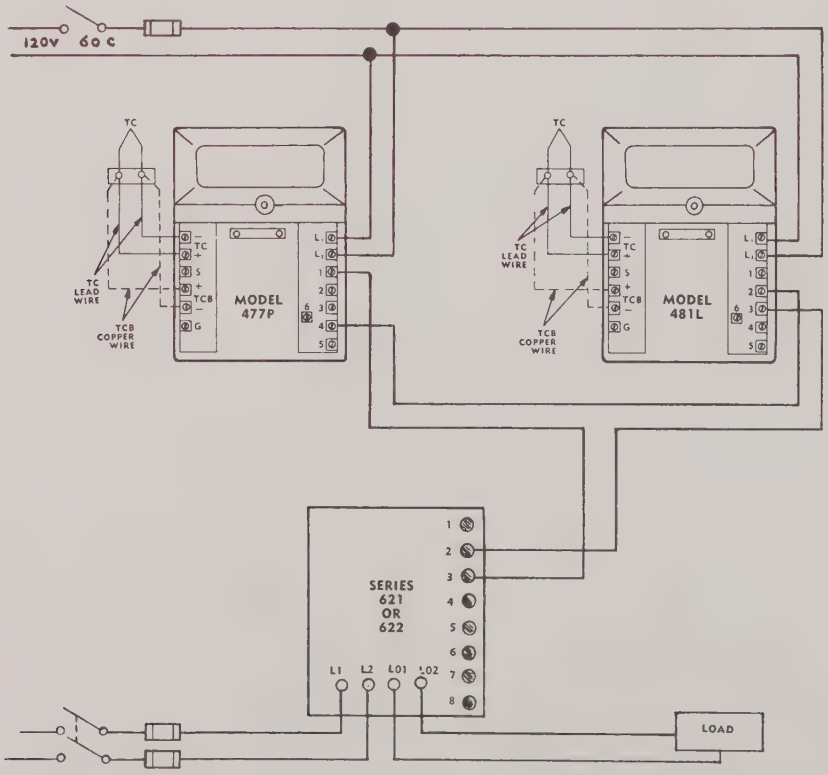


FIGURE 5

Model 481L Used with a Model 477P Controller
for Driving a Series 621 or 622 Power Controller

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Meter Shunt Wire

After the instrument is installed, disconnect the jumper wire across terminals marked "Shunt", "TC-" and "TC+". This wire is used to shunt or dampen the meter movement for protection during shipping, handling and installing the instrument, but should be removed for normal operation. Replace the shunt wire when handling or reshipping the instrument and position the red control set pointer fully upscale.

If the meter assembly is removed from the case, an automatic shunt device protects the meter assembly from damage. Other shunt wiring is not required.

Thermocouple Wiring

Do not run thermocouple extension wire with other power or control wiring. However, several thermocouple extension wires may be run in the same conduit if desired.

Use only the correct extension wire for the type of thermocouple specified on the meter scale. The types most commonly specified are:

Iron-Constantan	Type J
Chromel Alumel	Type K
Platinum-Platinum 10% Rhodium	Type S
Platinum-Platinum 13% Rhodium	Type R

Ordinary copper wire must not be used as extension wire for thermocouples, although it may be used with Barber-Colman Land Radiation Pyrometers and some other radiation detectors. See Barber-Colman Thermocouple Catalog for a full selection of thermocouple assemblies and extension wire.

Proper polarity (+) and (-) of the extension wire must be observed to obtain correct readings. The negative wire is usually coded red. Correct polarity of the extension wire can be checked by forming a temporary junction at the far end, heating this junction with a match, and noting the deflection of the meter indicator. An upscale deflection is proof of correct polarity of the extension wire.

The thermocouple should then be connected to the extension wire and the indicating pointer should again deflect upscale when the thermocouple hot junction is heated. If the indicator moves downscale, reverse only the thermocouple connections at the terminal block since the extension wire has already been correctly connected to the instrument.

Secure the extension wires firmly under the terminal screws. If desired, spade lugs may be used.

Thermocouple Break Protection (TCB)

Each instrument is equipped with thermocouple break protection (TCB). If a break in the thermocouple circuit occurs, the meter indicator will be driven upscale past the control set point, causing the power to the controlled load or process to be turned off and guarding against overheating when an open thermocouple circuit occurs.

Two systems of thermocouple break protection are used with the Series 481. Standard models of the instrument are provided with a small d-c voltage wired into the thermocouple circuit to drive the movement upscale in the event of an open circuit. If so specified, bridge type TCB is furnished. With the thermocouple forming one leg of the bridge circuit, a break in the thermocouple extension wire produces an unbalance causing the indicator to be driven upscale to shut off control power.

NOTE: Check to see that jumper wire on underside of control chassis is attached to pin ST for models equipped with standard type TCB or to pin BR if bridge type TCB. Models are shipped as ordered, but because of interchangeability of chassis, this should be verified.

Standard Type TCB

Instruments equipped with standard TCB do not require that the TCB be connected for proper operation of the instrument but its use may be desirable on some applications to guard against overheating in the event of an open thermocouple.

The preferred method of connecting TCB is shown in Figure 6. Use extension wire as required to make the connections between the instrument TC terminals and the thermocouple head. Use copper wire to connect the TCB terminals to the thermocouple head, observing polarity. Wiring for TCB may be run in the same conduit with thermocouple extension wire. After connections are made, check for any error of indicator reading that may have resulted.

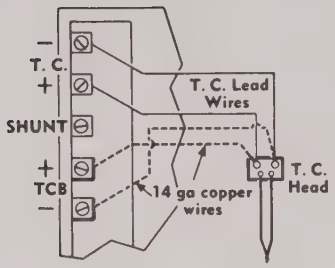


FIGURE 6

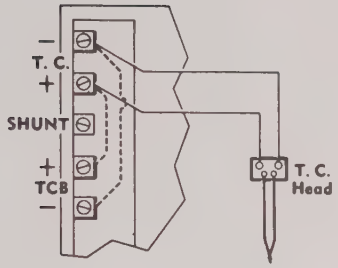


FIGURE 7

Although not recommended, an optional method of connecting TCB is to use jumpers at the instrument terminals as shown in Figure 7. As the length of extension wire used affects the amount of TCB compensation required, it is suggested that this method be used only with short wire lengths, 10 feet or less, and that the amount of TCB error be checked.

Standard Type TCB (continued)

To check for TCB operation, disconnect the thermocouple to simulate a broken thermocouple but leave the TCB wires connected to the extension wire. When the instrument is powered, the indicator should move upscale above the control set pointer to cause the control to go to the off position. To check for TCB error, power the instrument and read the temperature with the hot junction of the thermocouple held at a steady temperature. Then disconnect the wires at the TCB terminals, and note if the indicated temperature decreases. Reconnect to see if indicated temperature increases. If a shift in reading is noticed, adjust the screw on top of the plastic cover so that the reading with TCB connected is at the same point as read with TCB disconnected. If an adjustment was made, the ambient temperature reading will also be shifted downscale.

NOTE: Adjustment should be made for correct ambient temperature reading before this check is made. See section on Cold Junction Compensation.

If the instrument is equipped with bridge type thermocouple break protection, the need for any external TCB wiring is eliminated. See Figure 8.

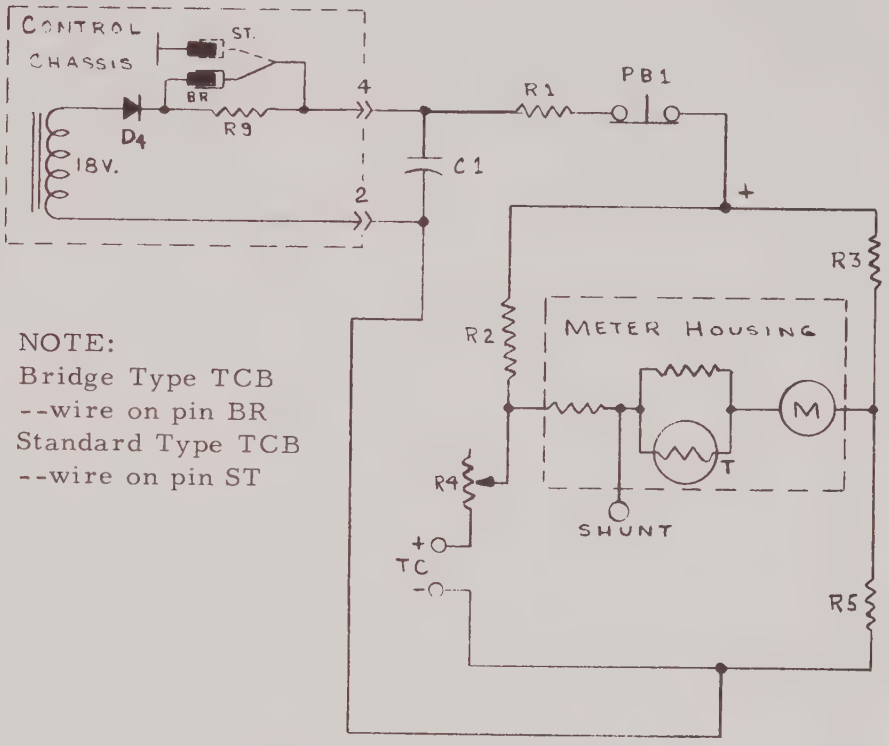


FIGURE 8

Bridge Type TCB

Bridge type TCB, when properly adjusted, eliminates the error that occurs with other types of TCB circuits. It also compensates for the thermocouple and extension wire resistance, as discussed in the section below. Adjustment is made in the following manner:

Remove the lower cover of the instrument, revealing the push button over the words "TCB ADJ" and the adjustable potentiometer underneath. With the thermocouple connected and maintained at a steady or fixed temperature, and with the instrument powered, depress the push button and note the meter indicator reading. Then release the push button and again note the indicator reading. If there is a difference between the two readings, adjust

Bridge Type TCB (continued)	the potentiometer with a screwdriver, with the push button released, until the meter indicator reading is the same as the initial reading when the push button was depressed. The proper adjustment is obtained when there is no discernable difference in meter readings with the push button depressed or released. To check for TCB operation, disconnect one of the thermocouple wires to simulate a broken thermocouple. With the instrument powered, TCB is functioning properly if the meter indicator is driven upscale above the control set pointer causing the power to the load to be turned off.

TCB, either standard or bridge type, cannot be used with radiation detectors or the Series 350 Reference Voltage Source. An instrument with standard TCB requires only that TCB connections not be made. If instrument was purchased with bridge type TCB, and it is later desired to convert for these applications, please consult your Barber-Colman field office.

Thermocouple and Leadwire Resistance Compensation

Standard Type TCB	The external resistance, for which the meter has been calibrated and as marked on the scale, is the combined resistance of the leadwire and thermocouple. Meters equipped for standard thermocouple break protection are usually calibrated for 15 ohms (Ext. Res. 15 ohms) which is greater than the combined resistance of most thermocouples plus leadwire used. The balance of the resistance, 15 ohms minus the actual external resistance, is inserted on a removeable resistance strip located just under the meter section. The resistance value is marked on the strip and is inserted at the time of the original order. Other values are available.
Bridge Type TCB	Instruments equipped with the bridge type TCB circuit are normally calibrated for 25 ohms which allows up to 20 ohms for the external thermocouple and leadwire resistance. An adjustable potentiometer (R4), located on the left terminal strip inside the lower compartment, is used to compensate for the difference in resistance between the allowable 20 ohms and the actual thermocouple plus leadwire resistance. The proper adjustment of this potentiometer also eliminates any TCB error. See page 12 for adjustment procedure.

Limit Control Action

The temperature limit set point is adjustable by use of the knob just below the instrument scale. The indicating pointer will move to indicate the temperature at the thermocouple. At start-up, the red signal lamp will light when the instrument is initially powered. With the indicator below the set pointer, the RESET push button on the front of the meter must be depressed to close the circuit to the main control device. In the Model 481L this closes terminals 2 to 3; in the Model 481H, the circuit is closed at the two large terminals on the front center of the electronic chassis. The red signal light will go out when the push button is released. If at any time the indicator should cross the control set point while moving in an upscale direction, relay action occurs to open the circuit to the main control devices and simultaneously light the red signal lamp. When the indicator drops below the control set pointer, the relay will not be energized, permitting the control device to apply power to the process, until the RESET push button is pressed again. The limit control circuit will not reset if the indicator is above the set pointer.

Control Adjustments

Alignment:

An alignment adjustment is located on the front of the Limitrol chassis and is accessible after removing the lower front cover of the instrument. Although also labeled "Reset", it is not to be confused with the RESET push button referred to above.

This adjustment provides a means of aligning the limiting control action with the indicator. If relay action does not occur at coincidence with the meter indicator and the control set pointer, an alignment adjustment should be made. Use a small screwdriver to position the tuning capacitor. With the indicator below the control set pointer, the RESET push button must be depressed after each shut-off action.

If alignment is completely out of adjustment, position the control set pointer to coincide closely with the meter indicator. Turn the slotted reset adjusting shaft completely clockwise. While holding the RESET push button continuously, turn the slotted shaft counterclockwise very slowly. Stop turning promptly when the red signal lamp lights. Release RESET push button and recheck operation by moving control set pointer upscale and downscale past the point of alignment with meter indicator.

Switching should occur at this point. If it does not, press the RESET push button again and make minor adjustments as may be required. Final adjustments should be made after the unit has been in operation 45 minutes and has obtained maximum stability.

Differential:

A potentiometer is factory adjusted to require approximately a 0.006" motion of the pointer to cause the Limitrol action to change from on to off. This setting handles the majority of applications and should not be readjusted except by a qualified instrument repair man. If it is desired to change the operating differential of the instrument relay, remove the control chassis to expose the potentiometer located beneath the printed circuit board. Turn the potentiometer clockwise with a small screwdriver to widen the differential, and counterclockwise to reduce it.

Cold Junction Compensation

For measuring temperature, thermocouples are the most commonly used sensing devices. They produce a voltage when there is a temperature difference between the "hot" or measuring junction and the "cold" junction located in the meter assembly. Since the difference in temperature between the hot and cold junction determines the amount of millivoltage produced, it is necessary to keep the cold junction temperature constant, or to compensate for any changes that occur at this point. The Series 481 compensates for temperature changes at the cold junction, either mechanically or electrically. Mechanical cold junction compensation, employing a bi-metallic strip, is furnished as standard on non-suppressed range instruments unless otherwise specified. Electrical cold junction compensation is usually provided with suppressed range instruments and can be supplied with any instruments that have bridge type TCB. See Figure 9.

After the instrument is mounted, the cold junction reading of the meter should be checked, making adjustments as described on the next page.

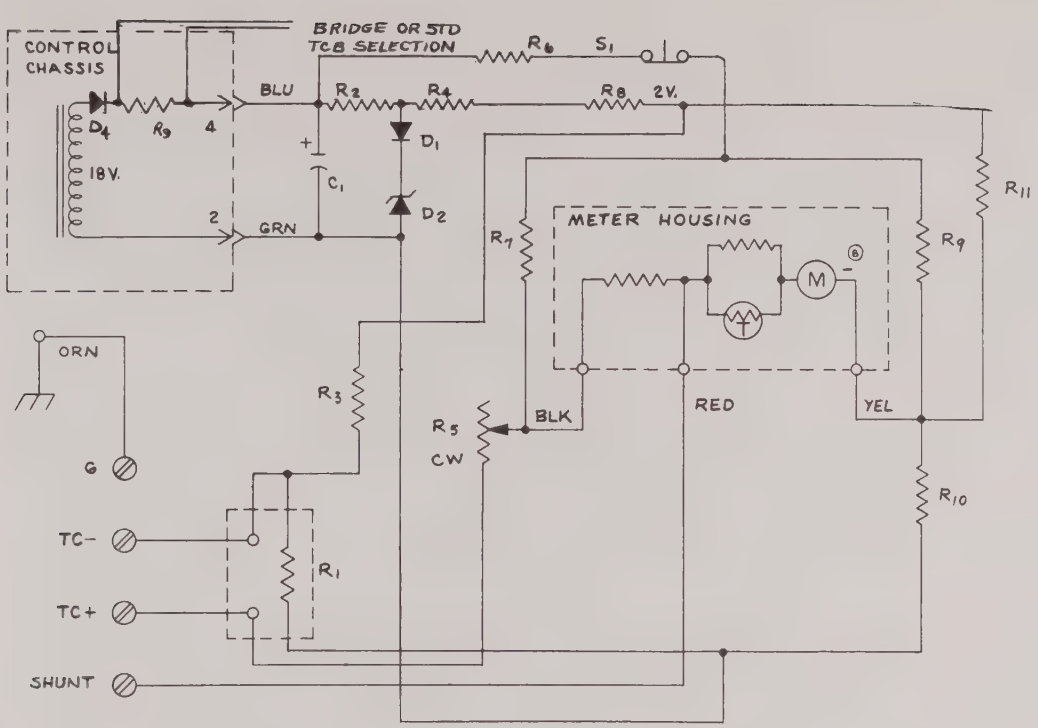


FIGURE 9

NOTES:

1. Electrical cold junction compensation is accomplished by utilizing the resistance change, due to temperature, of Resistor R1. Value depends on type of thermocouple used.

2. With electrical cold junction and suppression, value of R10 depends on the type of thermocouple and the amount of suppression desired.

Standard or Bridge TCB with Mechanical Cold Junction

If the instrument has mechanical cold junction compensation, the cold junction check is made in the following manner:

Disconnect power leads and TC leadwire at the instrument. The indicator should come to rest at the ambient temperature of the meter; it is not supposed to read zero. Place a thermometer at the TC instrument terminals to read ambient temperature.

If the pointer does not indicate the ambient temperature, slowly adjust the screw located on top of the meter cover until it does. Because cold junction compensation is automatic, further corrections for changes in the ambient temperature need not be made.

Bridge TCB with Electrical Cold Junction

If the instrument has a non-suppressed range but is equipped with the electrical cold junction feature and bridge type TCB, check for proper cold junction adjustment according to the following:

The meter indicator should read zero when the instrument is unpowered. If the meter is not at zero, adjust the screw located on top of the meter cover until zero is obtained. Connect a jumper wire between TC- and TC+ and with the instrument powered, adjust the TCB potentiometer so no indicator movement occurs when the TCB push button is depressed and released. Place a thermometer at the TC instrument terminals to measure the ambient temperature reading. With the instrument still powered, the meter indicator reading should be the same as the ambient temperature reading. Further adjustments are not required because of the automatic electrical cold junction compensation.

For instruments with a suppressed range using electrical cold junction compensation:

The meter indicator should come to rest at the lowest temperature reading on the scale when the instrument is unpowered. If it does not, slowly adjust the screw located on top of the meter cover until it does. The meter is then properly adjusted and needs no further adjustment because of automatic electrical cold junction compensation.

Calibration Check

The instrument has been calibrated at the factory to the specified limits of accuracy. No further adjustment need be made. If, however, it is later decided to check the calibration, obtain a Barber-Colman Model 330P Portable Potentiometer, or its equivalent, and perform the following:

Standard TCB Mechanical Cold Junction

If instrument is equipped with standard TCB and mechanical cold junction compensation:

Follow directions outlined in the Model 330P Instruction Manual on page 11.

Bridge TCB with Mechanical or Electrical Cold Junction

If instrument is equipped with bridge type TCB:

Remove the TC wire and short out the TC terminals by connecting a jumper wire between terminals marked TC- and TC+. Then, with the instrument powered, adjust the TCB potentiometer so no meter indicator movement occurs when the TCB push button is depressed and released. With the jumper wire then removed, and the instrument unpowered, connect a Barber-Colman Model 330P (or equivalent) to the thermocouple terminals and follow instructions stated below.

Bridge TCB with Mechanical Cold Junction

If instrument has mechanical cold junction compensation:

Procedure for calibrating is as outlined in the Model 330P Instruction Manual -- except that the Model 330P must be set for zero external resistance instead of the external resistance marked on the scale of the Series 481.

Bridge TCB with Electrical Cold Junction

If the instrument has electrical cold junction compensation and a non-suppressed range:

Calibrating procedure is as outlined in the Model 330P Instruction Manual except for the following: The Model 330P must be set for zero external resistance, and for a zero cold junction setting instead of ambient. Since most thermocouple

Bridge TCB with Electrical Cold Junction (continued)	tables are based on 32°F reference temperature, the 0°F millivoltage equivalent has to be added (algebraically) to the desired temperature millivoltage equivalent. For example, the proper 400°F I/C setting on the potentiometer would be: (0°F) = - 0.89 mv, and 400°F = 11.03 mv 11.03 - (- 0.89) = 11.92 mv, which is the proper setting Suppressed range instruments: These models require a special procedure for calibrating the instrument. Contact your Barber-Colman field office if a calibration check is believed to be necessary.

Maintenance and Service Checks

The Series 481 instruments are well designed and manufactured of high grade components and with normal care will give uninterrupted service for a long time. It is good practice, however, to have information as to service and spare parts for emergency servicing. Where a number of instruments are located together, the plug-in parts are interchangeable to allow minimum inventory.

When trouble is encountered, the service man should familiarize himself with the process and instrument application to determine the exact function of the instrument as applied. The instrument trouble usually can be traced to two basic problems: measurement or control.

Measurement trouble can be detected by observing the pointer position. If the measured temperature is known to be in error, check the following:

1. Open or broken thermocouple, leadwire or connector.
2. Deteriorated thermocouple. Compare reading with a test thermocouple.
3. Ascertain that instrument is grounded.
4. Accidental shorts, grounds or moisture in the leadwire (especially with asbestos type insulation).
5. High resistance in leads due to loose connectors, poor splicing, dirty switch contacts, and other faulty connectors.

6. Problems caused by vibration or shock.

7. Meter accuracy. This can be checked with a Model 330P Portable Potentiometer.

8. Errors due to oil and grease. Do not oil or grease any part of the instrument.

9. Incorrect cold junction (ambient) setting. The correctness of this setting should be checked following any other meter servicing.

10. Incorrect TCB adjustment (see section on Thermocouple Break Protection).

Control trouble may be detected by observing control point and indicator pointer position. If control action does not occur at control point, do the following:

1. Check electrical connectors and correctness of line voltage. Ascertain as to whether trouble is internal or external to the instrument.

2. Adjust pointer alignment as described on page 15.

3. If the instrument does not operate (i.e., red signal lamp remains lighted when the RESET push button is depressed) make sure the meter indicator is downscale from the control set point, depress the RESET push button, and turn the reset adjustment through its entire adjusting range. If the red lamp then goes out, check for proper reset alignment as described under Control Adjustments. If the red lamp does not go out, further servicing or replacement of the control chassis is suggested.

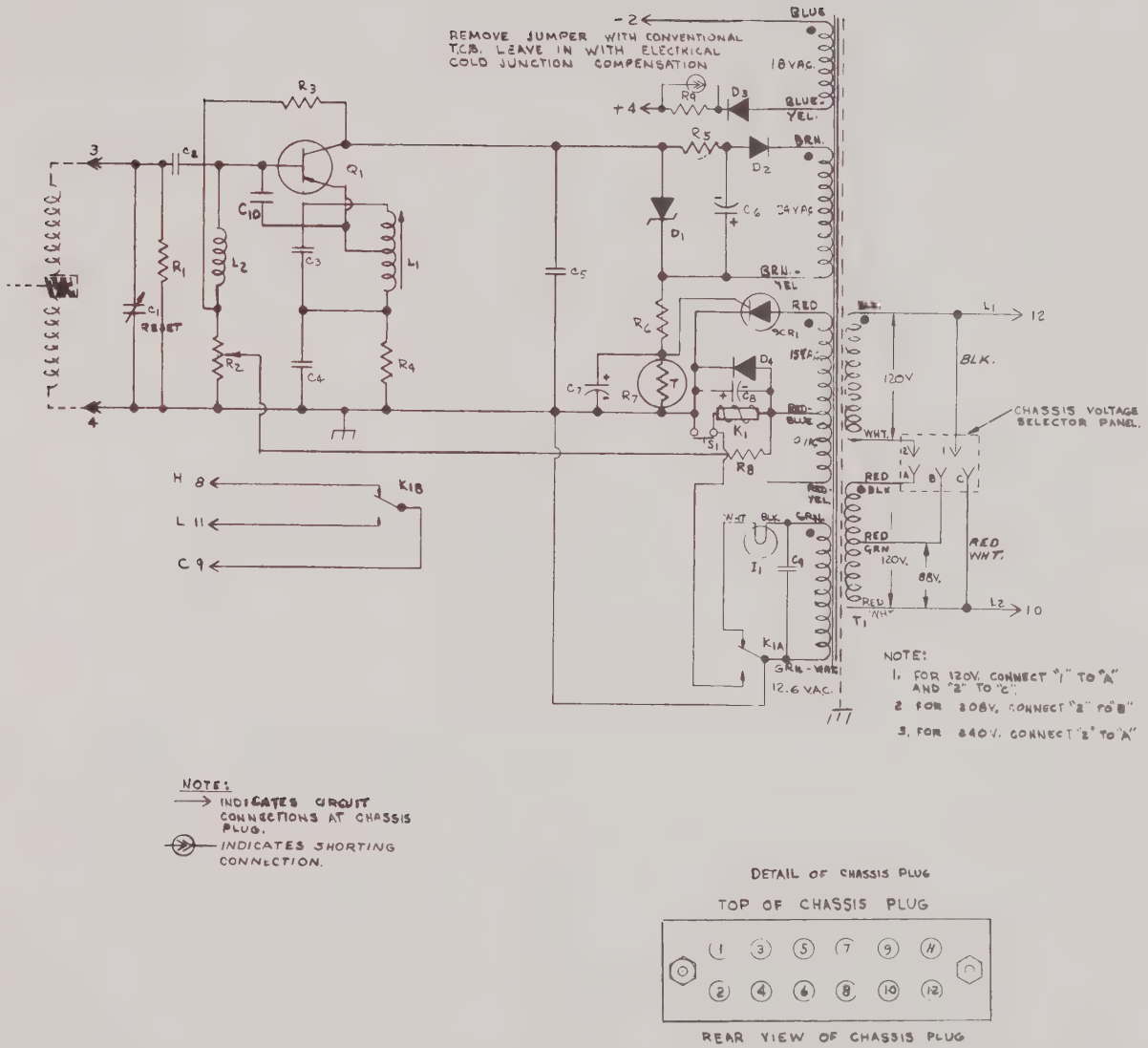


FIGURE 10

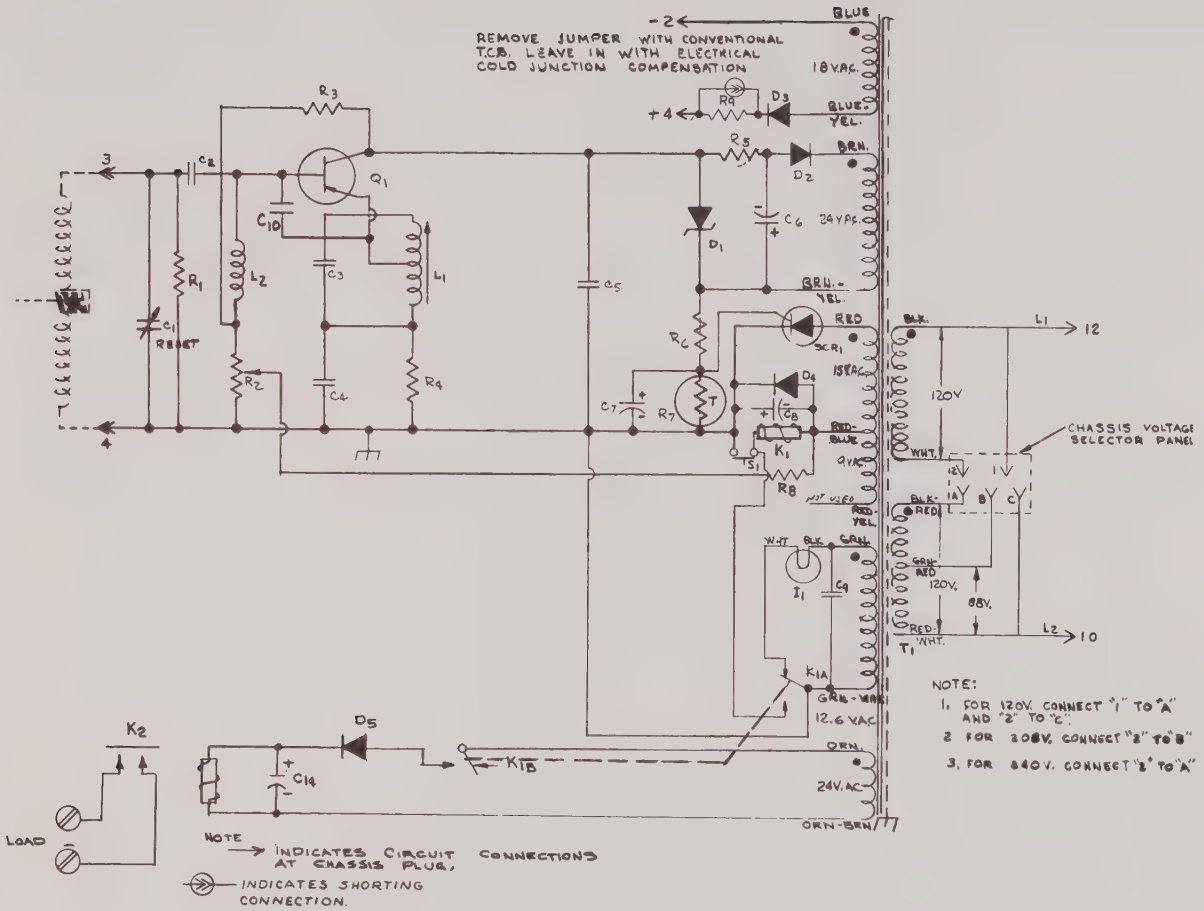
Model 481L Internal Wiring Diagram

F-12958

Replacement Parts List

MODEL 481L

Item	Part Number	Description
C1	39-193	2-20 mmfd Capacitor
C2	39-203	270 mmfd Capacitor
C3	39-087	62 mmfd Capacitor
C4	39-203	270 mmfd Capacitor
C5	39-103	.01 mfd Capacitor
C6	39-153	50 mfd Capacitor
C7	39-153	50 mfd Capacitor
C8	39-153	50 mfd Capacitor
C9	39-196	.22 mfd Capacitor
C10	39-089	5 mmfd Capacitor
D1	37-093	12 volt Zener Diode
D2	EYZP-384	Silicon Diode
D3	37-030	Silicon Diode
D4	37-030	Silicon Diode
I1	36-034	12.6 volt Bulb
K1	A-5521	Relay
L1	41-130	Choke
L2	41-133	Choke
Q1	31-050	Transistor (2N2188)
R1	CYZR-170-1	22,000 ohm Resistor
R2	BYZR-93-13	1000 ohm Potentiometer
R3	40-082	33,000 ohm Resistor
R4	40-077	270 ohm Resistor
R5	CYZR-133-2	1500 ohm Resistor
R6	CYZR-170-71	390 ohm Resistor
R7	31-048	4850 ohm Thermistor
R8	CYZR-170-43	220 k ohm Resistor
R9	CYZR-170-9	68 k ohm Resistor
SCR1	37-059	Silicon Controlled Rectifier
S1	32-164	SPST Push Button Switch
T1	30-142	Power Transformer



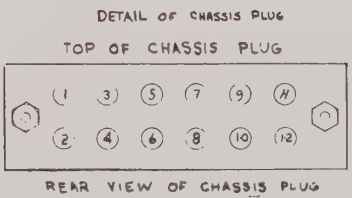


FIGURE 11

Model 481H Internal Wiring Diagram

F-12958

Item	Part Number	Description
C1	39-193	2-20 mmfd Capacitor
C2	39-203	270 mmfd Capacitor
C3	39-087	62 mmfd Capacitor
C4	39-203	270 mmfd Capacitor
C5	39-103	.01 mfd Capacitor
C6	39-153	50 mfd Capacitor
C7	39-153	50 mfd Capacitor
C8	39-153	50 mfd Capacitor
C9	39-196	.22 mfd Capacitor
C10	39-089	5 mmfd Capacitor
C11	39-181	50 mfd Capacitor
D1	37-093	Zener Diode - 12 volt
D2	EYZP-384	Silicon Diode
D3	37-030	Silicon Diode
D4	37-030	Silicon Diode
D5	37-066	Silicon Diode
I1	36-034	12.6 volt Bulb
K1	A-5521	Relay
K2	38-156	Relay
L1	41-130	Choke
L2	41-133	Choke
Q1	31-050	Transistor (2N2188)
R1	CYZR-170-1	22,000 ohm Resistor
R2	BYZR-93-13	1000 ohm Potentiometer
R3	40-082	33,000 ohm Resistor
R4	40-077	270 ohm Resistor
R5	CYZR-133-2	1500 ohm Resistor
R6	CYZR-170-71	390 ohm Resistor
R7	31-048	4850 ohm Thermistor
R8	CYZR-170-43	220 k ohm Resistor
R9	CYZR-170-9	68 k ohm Resistor
SCR1	37-059	Silicon Controlled Rectifier
S1	32-164	SPST Push Button Switch
T1	30-143	Power Transformer

Electronic Parts in Meter Section:

Series 481 with Standard TCB Only

Part Number	Description
A-3497	External Resistance Compensator

Series 481 with Bridge Type TCB

CYZR-326-54	2.5 k Resistor
40-162	10 k Resistor
CYZR-326-103	5 ohm Resistor
29-133	25 ohm Potentiometer
40-070-2	47 k Resistor

Suggested Replacement Parts to Keep on Hand

Quantity	Part Description	Part Number
2	MAZDA Pilot Lamps	36-034
1	Replacement Thermocouple	Barber-Colman can supply thermocouple assemblies, components or wire for any requirement you may have. If need be, delivery will be made in 48 hours. Contact your nearest Barber-Colman field office.
1	Indicating Meter Assembly	A-6175
1	Control Chassis:	
	Model 481L	A-6004
	Model 481H	A-6002

We do not recommend electronic component replacement except by well equipped instrument repair shops. Barber-Colman, Industrial Instruments Division, maintains service and repair facilities in many major cities in the United States and Canada. Consult your yellow page directory.

MATERIAL WARRANTY

All equipment except tubes, photocells, and thermocouples, which within one year from date of shipment is found to have been originally defective, will be repaired (replaced if necessary) free of charge if returned prepaid to the Factory at Rockford, Illinois.

MP MASTER
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